130S-1

ELECTRICAL MOTORS

AG 130-S

UNIT OBJECTIVE

After completion of this unit, students will be able to identify the different types of electrical motors, understand the different uses, and identify the best electrical motor for a certain job. This knowledge will be demonstrated by completion of assignment sheets and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Understand terms associated with electric motors.
2. Identify different types of electrical motors.
3. Understand the different characteristics of each type of electrical motor.
4. Identify parts of an electrical motor.
5. Identify requirements of an electrical motor.
6. Identify information found on the nameplate of an electrical motor.
7. Understand the reasons for different type of motor enclosures.
8. Name factors to consider in selecting electric motors.

GENERAL INFORMATION

A. Terms

1. Single phase – Type of electrical service available to most farms; requires one transformer between power supplier and customer
2. Split phase motor – Cheapest electric motor available; used for easy starting loads.
3. Induction-run motor – Motor that runs by induced current and does not have windings in the motor.
4. Repulsion-start motor – Motor that has windings in the rotor and also has brushes and a commutator.
5. Capacitor-start motor – Motor that has a capacitor wired in series with the starting windings.
6. Horsepower (hp) – Unit of mechanical power which is equal to 746 watts of electrical power
7. Short circuit – A circuit where the current flows to a ground with no resistance in the circuit.
8. Three phase motor – Most rugged, reliable, and satisfactory type of motor available; used for fairly difficult starting loads.
9. RPM – Revolutions per minute
10. Automatic motor control – Switch, relay, and/or a contactor capable of responding to a device that senses variations in temperature, humidity, light, and pressure.
11. Relays – Device capable of utilizing a sensing signal to open and close a (switch) circuit.
12. Commutator – Switch for revering the direction of an electrical motor

B. Types of A.C. single-phase, induction-run motors

1. Split phase

    a. Cheapest electric motor available
    b. Available in sizes up to 1/3 hp
    c. Uses single-phase power
    d. Uses 120-volt and/or 240 volt service
    e. Used on easy starting loads
    f. Examples: Grinders, saws, washing machines

2. Repulsion-start

    a. Uses single-phase power
    b. Available in sizes from 1/6 to 10 hp
    c. Uses 120 volt and/or 240 volt service

d. Used on hard to start loads
e. Examples: Bunk feeders, milking machines, silage blowers

3. Capacitor-start, capacitor-run

a. Uses single-phase power
b. Has two capacitors; one for starting and one for running
c. Available in sizes of 5 to 10 hp
d. Used on hard-to-start loads
e. Examples: Pumps, large conveyors, feed mills

4. Repulsion-start, capacitor-run

a. Uses single phase power
b. Is a combination, the capacitor helps maintain running efficiency after the motor reaches operating speed
c. Available in sizes of 1 to 15 hp
d. Examples: Grain conveyors, deep well pumps, barn cleaners

C. Three Phase Motors

1. Uses three phase 220/240 or 440/480
2. Low to medium starting current with high starting torque
2. Available in 1/2 to 400 hp or greater
3. Examples: Irrigation pumps, elevators, conveyors

D. Variable Speed Motors

1. Types of Variable Speed Motors

a. Adjustable-voltage D.C.
b. Adjustable-voltage A.C. (Most commonly used on farms today.)
c. Adjustable-frequency A.C.
d. Wound-rotor motors

2. Types of Voltage controls

a. Variable transformer
b. Series resistors
c. Solid-state power control

3. Precautions in Operating a Variable Speed Motor

a. Limit the low speed setting to provide proper bearing lubrication

b. Control unit should provide sufficient voltage to start the motor under a load while at low speed setting.
c. The lowest speed should still provide enough ventilation to prevent overheating

E. Parts of an Induction Run Motor

1. Ventilated end bell or shield
2. Stator and frame
3. Thermal protection
4. Centrifugal starting switch
5. Sleeve bearing
6. Rotor and fans
7. Resilient mounting

F. Electric Motor Nameplate & Standards

1. Type of current – AC or DC
2. Type of overload protection
3. Horsepower – Horsepower the motor will produce at rated speed
4. RPM – Speed or speeds the motor will operate. Generally there are four speeds the motors are designed to operate, 3,400RPM (2 pole), 1,725RPM (4 pole), 1140 (6-pole), and 825RPM (8-pole)
5. Temperature at which is to be operated
6. Volts – Voltage at which the motor may be operated. Generally, 115/120 or 220/440. More information on the backside of the conduit box cover.
7. Amps – Amount of Amps used at operating load
8. Type of enclosure
9. Motor type – *sp* for split phase, cs for capacitor-start etc.
10. Type of frame – Frame size as defined by the National Electric Code
11. Cycle – Indicates frequency at which the motor is to be operated, almost always 60 cycles
12. Serial number – Manufactures Code Number

G. Selecting an Electric Motor

1. Type of electrical power available (Three phase or single phase)
2. Type and size of load
3. Conditions under which a motor must operate (Indoor or outdoor, wet or dry)
4. Types of motor enclosures

a. Drip-proof – Water can drip on the motor with out causing any harm
b. Splash-proof – Stops water from coming in at a 100* angle

c. Weather-protected – Designed to minimize the entrance of rain, snow, and dust
d. Totally-enclosed – Prevent free exchange of air
e. Dust-ignition-proof – Built to exclude ignitable amounts of dust into the motor
f. Submersible – May be submersed in water, submersible pumps

5. Type of Frame – A standard size is set up by the government, so one make can be replaced by another. For example, a General Electric motor can be replaced by a Dayton motor by knowing the type of frame.

a. Bolt pattern for mounting
b. Shaft Size

1) Diameter of shaft
2) Length of the shaft
3) Height from the base of the motor

6. Estimate the motor size needed

a. If a job can continuously be operated by hand, a 1/4 hp electric motor will do the job
b. If equipment is driven satisfactory by a gasoline engine, the engine can normally be replaced with an electric motor of about 2/3 to 3/4 as much horsepower as a gasoline engine
Example: To replace a 2 hp gasoline engine

2 X 2/3 = 4/3 = 1 ½ Select a 1 ½hp electric motor

H. Power Consumed by Motors

1. Approximate figures for a 2 HP motor are as follows:

a. While Starting	4000 watts
b. While Idling	400 watts
c. While Delivering 1/2 HP	750 watts
d. While Delivering 1 HP	1150 watts
e. While Delivering 1 ½HP	1500 watts
f. While Delivering 2 HP	2000 watts
g. While Delivering 2 ½Hp	2600 watts
h. While Delivering 3 HP	3300 watts

* Note, motors operate the <u>most efficiently at rated horse power</u>

I. Reversing Motors

1. Single phase motors

a. Repulsion-Start motors

1) Change the position of the brushes

b. Other single phase motors

1) Reverse the two leads of the starting winding in respect to the two leads from the running winding.

2. Three phase motors

a. Reverse any two of the three leads

J. Causes of motor failure

1. Overheating – Heat is one of the most destructive causes of motor failure.

Overheating is caused by
a. Overloading
b. Low voltage
c. Excessive ambient temperature
d. Poor cooling caused by dirt or lack of ventilation.

2. Moisture

a. Improper selection of motor enclosure

3. Bearing failure

a. Poor lubrication
b. Bearings may fail in unused motors that are not rotated for extended periods

4. Starting Mechanism failure

a. Not kept free of dirt and moisture

5. Belt too tight or to loose
6. Machine locked or jammed

Activity:

1. Have students take apart old junk motors and look at the internal parts.
2. Have students look at motors at home or on the farm and report back the different types of motors, enclosures, etc, they found.
3. Have students wire a new cord on an electric motor.

References:

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McReynolds, Ray (1997) STEP BY STEP GUIDE BOOK ON HOME WIRING, Step-By-Step Book Co. Salt Lake City, Utah 1-800-678-1500

SELECTING AND USING ELECTRIC MOTORS, U.S. Department of Agriculture, Farmers Bulletin No. 2257

Special Material and Equipment:

Old electric motors, electrician's pliers, solid single 14 gauge wire, electrician's tape, screwdriver, pocket knife, cords, extra plugs. Hand tools suitable for electrical wiring, cable ripper, wire stripper, 14-2 w\g cable, switch box, octagon box, single-pole switch, voltage meter.

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Name_____
Date_____
Score_____

ELECTRICAL MOTORS

Multiple Choice, Select the most correct answer for the following questions.

1._____ What type of motor enclosure would you used in a damp situation where water drips on to the motor?

a. Splash proof
b. Drip proof
c. Weather proof
d. Dust proof

2._____ What type of motor enclosure would you used in a feed mill operation where dusty conditions are high?

a. Splash proof
b. Drip proof
c. Weather proof
d. Dust proof

3. _____ What are considerations for selecting a motor?

a. Type of electrical power available (single or three phase)
b. Type and size of load.
c. Conditions under which the motor must operate
d. All the above

4._____ When does an electrical motor consume the most power?

a. while running at rated load
b. while starting
c. while running above the rated load
d. while at idle

5._____ What does the nameplate data, Type of Frame NOT include?

a. Shaft size
b. Bolt pattern
c. RPM
d. Shaft length

Short Answer, answer the following questions with a short answers.

6. Name three causes of electrical motor failure

    a._____

    b._____

    c._____

7. To replace a 5hp-gasoline engine, what size of electrical motor would you need?

8. Name four items found on an electrical motor nameplate.

    a._____

    b._____

    c._____

    d._____

9. What type of an electrical motor would be used on irrigation pump requiring 20hp.

10. How would you reverse the following types of motors?

    a. single phase, Repulsion Start

    b. single phase, other types

    c. three phase motor

Answer Sheet

1. B
2. D
3. D
4. B
5. C
6. Any three of the following; overheating, bearing failure, belt to tight, moisture, locked or jammed
7. 5 x 2/3 = 10/3 = 3 1/3 = 3 1/3hp or 3 1/2hp motor
8. Any four of the following; Type of current AC or DC, type of overload protection, horsepower, RPM, operating temperature, volts, amps, type of enclosure, motor type, cycle, type of frame, serial number
9. Three-phase motor with weather proof enclosure
10. a. rotate brushes, b. reverse leads c. reverse any two hot leads

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PARTS OF INDUCTION-RUN MOTOR